Qualitative Pathway-Initiated Risk Assessment of the Importation of Fresh Pitaya Fruit from Mexico and Central America into the Continental United States

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I. Introduction

This pest risk assessment was prepared by the Animal and Plant Health Inspection Service (APHIS) of the United States Department of Agriculture (USDA) to examine plant pest risks associated with the importation for consumption of fresh pitaya fruit from Mexico and Central America into the Continental United States. This risk assessment examines the genus *Hylocereus* and associated genera because the terms "pitaya" and "pitahaya" commonly refer to a number of taxonomically related genera (Jacobs, 1999; Mizrahi *et al.*, 1997; Popenoe, 1939). This risk assessment considers the risks associated with "pitahaya", "pitajaya", "pitajuia", "pitalla" or "pithaya" (Popenoe, 1939; *see* Section C for the complete listing with synonymies). The plant pest risk for these crops and any hybrids among these plants (Mejia *et al.*, 2002; Mizrahi and Nerd, 1999; Raveh *et al.*, 1993; Tel-Zur *et al.*, 2001; Tel-Zur *et al.*, 1999; Weiss *et al.*, 1995) is assessed within this document. The term "pitaya" is used throughout this document to refer to all these botanically related cacti that produce edible fruit except for species of *Opuntia*..

This qualitative pest risk assessment estimates risk using the qualitative terms "high", "medium" and "low" rather than probabilities or frequencies. The details of the methodology and rating criteria are in the document: *Pathway-Initiated Pest Risk Assessment: Guidelines for Qualitative Assessments, Version 5.02* (USDA, 2000).

International plant protection organizations, such as the North American Plant Protection Organization (NAPPO) and the International Plant Protection Convention (IPPC) of the United Nations Food and Agriculture Organization (FAO), provide guidance for conducting pest risk analyses. The methods for initiating, conducting and reporting used in this pest risk assessment are consistent with these guidelines. Biological and phytosanitary terms are used as in the NAPPO Glossary of Phytosanitary Terms (Anonymous, 1999b) and the Definitions and Abbreviations (Introduction Section) in International standards for Phytosanitary Measures, Import Regulations: Guidelines for Pest Risk Analysis (FAO, 1996) and the Glossary of Phytosanitary Terms (FAO, 2001).

II. Risk Assessment

Pest risk assessment is a component of an overall pest risk analysis. The Guidelines for Pest Risk Analysis (FAO, 1996) describe three stages in pest risk analysis. This document satisfies the requirements of FAO Stages 1 (initiation) and 2 (risk assessment), by separately considering each area of inquiry.

A. Initiating Event

This pest risk assessment is commodity-based or "pathway-initiated" because the USDA was requested to authorize importations of fresh pitaya fruit from Mexico and Central America into the Continental United States. This is a potential pathway for the introduction of plant pests on the fruit. The authority to regulate fruit and vegetable importation is codified at 7 C.F.R. § 319.56.

B. Assessment of the Weediness of Pitaya

If pitaya poses a risk as a weed pest, then a "pest-initiated" pest risk assessment is initiated. The cacti that produce pitaya fruit pose a risk of becoming weeds from abandoned plants, and APHIS believes the risk of weediness associated with consumption of the fruit appears low.

Introductions of the "Night-blooming Cereus," *H. undatus* (Haw.) Britton & Rose, became naturalized stands in 10 parks/preserves in six counties in South Florida that were treated and are no longer a factor affecting the native plant community; *H. undatus* was reclassified from a Category II invasive species to the "to be watched" list (Burks, 2001). The naturalized stands in Florida grew from abandoned cultivation or discarded landscaping material (Burks, 2001). Introductions of this plant into Hawaii as an ornamental during the 1800's (Morton, 1987) did not lead to listing as a weed, and generally, it is not known to produce fruit in Hawaii (Neal, 1965). The seed are disseminated by birds (Barbeau, 1993).

This same species (*H. undatus*) is naturalized in Vietnam and called "thanh long" (Mizrahi *et al.*, 1997). It is cultivated in many tropical and subtropical areas, and is considered an escape from cultivation in parts of Latin America (Kimnach, 1984). Australia permits four species of *Hylocereus* (*H. guatemalensis*, *H. ocamponis*, *H. polyrhizus*, and *H. undatus*) into all of the country, but bans other members of the genus, except for the State of Western Australia which restricts all members of the genus except for *H. undatus* cultivated as an ornamental (Randall, 2001).

Table 1. Assessment of the Weediness Potential
Commodity: Fruit from *Hylocereus* species (Cactaceae) **Phase 1:** Species of *Hylocereus* are native in Central Mexico and parts of South America. The species of *Hylocereus* that produce pitaya fruit are: *H. costaricensis* (synonym = *Cereus trigonus* var. *costaricensis*), *H. ocamponis* (= *C. ocamponis*), *H. polyrhizus* (= *C. polyrhizus* and *H. lemairei*), and *H. undatus* (Haw.) Britton & Rose (= *C. triangularis, C. tricostatus, C. trigonus* var. *guatemalensis*, *C. undatus*, *H. guatemalensis*, *Cactus triangularis*, and *H. tricostatus*). The members of this genus are not native to the United States, but *H. undatus* was introduced as a cultivated ornamental (ARS, 2001; Solomon, 2002). Native populations of other genera are distributed within the United States (*Acanthocereus tetragonus*, *Stenocereus thurberi*) and *Cereus hildmannianus* (= *Cactus peruvianus*, = *C. uruguayanus*) is on the Hawaiian Noxious Weed and Seed list (ARS, 2001). **Phase 2:** Is the species listed in: No Geographical Atlas of World Weeds (Holm *et al.*, 1979) No World's Worst Weeds (Holm *et al.*, 1977; Holm *et al.*, 1997) No Report of the Technical Committee to Evaluate Noxious Weeds for Federal Noxious Weed Act (Gunn and Ritchie, 1982) No Economically Important Foreign Weeds (Reed, 1977) No Weed Science Society of America list (WSSA, 1989) Yes Are there any references indicating weediness? *e.g.*, AGRICOLA, CAB, Biological Abstracts, AGRIS; search on "species name" combined with "weed" **Phase 3:** Some members of the various pitaya genera are listed and known as weeds, including *H. undatus*. Populations of this plant became weedy in Florida until eradicated (Burks, 2001). Discarded fruit are not known to cause problems as weeds, but abandoned plants become naturalized in suitable environments. There is evidence that seed pass through the human digestive system intact (Nabhan, 1985), but the viability of such seed is unknown. If there is proper disposal of rejected fruit and edible fruit is consumed then the potential for these cacti to demonstrate weediness is low.

C. Decision History and Pest Interceptions

In 1997, the entry of *Hylocereus undatus* from Vietnam was denied because of the lack of an approved treatment for *Bactrocera dorsalis* and *B. cucurbitae*. In 1995, the entry of *Acanthocereus* from Nicaragua was denied because of *Ceratits capitata*. In 1992, the entry of *Acanthocereus* spp., *Hylocereus* spp., *Lemaireocereus* spp., and *Selenicereus* spp. from Belize was denied because of the lack of an approved treatment for *Anastrepha* spp., *A. ludens*, and *C. capitata*. In 1988, the entry of *Hylocereus* spp. from Colombia was denied because of the lack of an approved treatment for *C. capitata*.

Pest interceptions listed under the name *Hylocereus* reflect only a portion of the total interceptions on imported "pitaya" fruit (PIN 309, 2001). Port officers were likely to ascribe the interception to the genus *Acanthocereus* based on a good faith reliance on the illustrated fruit guide in the manual for non-propagative material (USDA, 1999) which stated that fruit of *H. undatus* is *Acanthocereus* fruit. Also, the botanical nomenclature is unsettled, and there are many synonyms as summarized below (ARS, 2001; Solomon, 2002).

The fruit of cacti that are referred to as "red pitaya" that are assessed in this document include: *Acanthocereus occidentalis*, *A. tetragonus* (= *A. colombianus*, *A. floridanus*, *A. pentagonus*, *A. pitajaya*, *Cactus pentagonus*, *C. pitajaya*, *C. tetragonus*, *Cereus pentagonus*, *C. pitajaya*), *Cereus hildmannianus* (= *Cactus peruvianus*, *Cereus uruguayanus*), *Echinocereus conglomeratus* (= *C. conglomeratus*), *E. stramineus* (= *C. stramineus*, *E. enneacanthus* var. *straminues*), *Escontria chiotilla* (= *C. chiotilla*), *Hylocereus costaricensis* (= *C. trigonus* var. *costaricensis*), *H. ocamponis* (= *C. ocamponis*), *H. polyrhizus* (= *C. polyrhizus*, *H. lemairei*), *H. undatus* (= *Cactus triangularis*, *Cereus triangularis*, *C. tricostatus*, *C. trigonus* var. *guatemalensis*, *C. undatus*, *H. guatemalensis*, *H. tricostatus*), *Myrtillocactus geometrizans* (= *C. geometrizans*), *Stenocereus griseus* (= *C. griseus*), *S. gummosus* (= *C. gummosus*), S., *queretaroensis* (= C. *queretaroensis*), *S. stellatus* (= *C. stellatus*), *S. thurberi* (= *C. thurberi*, *Lemairocereus thurberi*, *Marshallocereus thurberi*, *Pachycereus thurberi*) (ARS, 2001; Solomon, 2002). Fruit from naturalized or artificially propagated plants of these species may be exported in compliance with the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES, 2002).

Table 3. Pests in or on pitaya hosts that were intercepted from passenger baggage and identified to species (PIN 309, 2001).

Pest name	Host	Country, Dates[1]
Acutaspis albopicta	*Hylocereus*	Mexico, 1999
Ceratitis capitata	*Acanthocereus*	Argentina, 1994; Greece, 1989; Italy, 1989 (2); Portugal, 1989
Dysmicoccus neobrevipes	*Hylocereus*	Vietnam, 2001
	Acanthocereus	Vietnam, 1994 (2), 1998; Cambodia, 1995; Singapore, 1995
Ogdoecosta biannularis	*Hylocereus*	Mexico, 1994
Opuntiaspis philococcus	Cactaceae	Mexico, 1992 (2), 1993, 1994 (2), 1996 (6), 1997 (4)
	Cereus	Mexico, 1994 (2), 1995, 1997, 1998, 1999 (7), 2000 (6), 2001 (6)
	Echinocereus	Mexico, 1995, 1995, 1996, 1997, 1999
Planococcus minor	*Acanthocereus*	Vietnam, 1994 (2), 1997, 1999, 2001
	Cactaceae	Korea, 1991
	Cereus	Vietnam, 2000
	Hylocereus	Singapore, 2001

[1]The number of interceptions is given in parentheses only if more than one interception occurred in that year.

D. Pests Associated with Pitaya in Mexico and Central America

In this risk assessment, Table 3 reports the pests associated with pitaya if, and only if, populations of that pest also are reported in the countries of Mexico and Central America. This table should not be interpreted to infer that all pests known to affect pitaya in the world are listed. This table only presents information about a pest's prevalence relative to the risks associated with the importation of pitaya from these countries, along with the host associations and regulatory data used to select the quarantine pests given detailed biological analysis.

Table 3: Summary of pests associated with Red Pitaya in Mexico and Central America.

Organism	Geographic Distribution[1]	Plant Part	Quarantine Pest	Follow Pathway	References
ARTHROPODA					
Acutaspis albopicta (Cockerell) (Homoptera: Diaspididae)	CR, GT, HN, MX, SV	Fruit	Yes	Yes[2]	Miller *et al.*, 1985; PIN 309, 2001
Alkindus atratus Distant (Hemiptera: Thyreocoridae)	CR, GT, HN, NI, PA, SV	Fruit	Yes	Yes[2]	Anonymous, 1994; PIN 309, 2001; Henry and Froeschner, 1988; Saunders *et al.*, 1983
Anastrepha sp. (Diptera: Tephritidae)	BZ, CR, GT, HN, MX, NI, PA, SV	Fruit	Yes	Yes	Anonymous, 1999a; Hernandez-Ortiz, 1992; Liquido *et al.*, 1991; PIN 309, 2001; White and Elson Harris, 1992
Apiomerus sp.[3] (Hemiptera: Reduviidae)	MX	Fruit, Infl.[4], Stem	No	Yes	Castillo-Martinez *et al.*, 1996; Slater and Baranowski, 1978
Atta cephalotes (L.) (Hymenoptera: Formicidae)	NI	Fruit, Infl., Stem	Yes	Yes[2]	Anonymous, 1994; Hill, 1983; Morton, 1997; Romero, 1994
Atta sp.[3] (Hymenoptera: Formicidae)	MX, NI	Fruit, Infl., Stem	Yes	Yes	Anonymous, 1994; Barbeau, 1993; Castillo-Martinez *et al.*, 1996; Hill, 1983; Morton, 1997

Organism	Geographic Distribution[1]	Plant Part	Quarantine Pest	Follow Pathway	References
Cactophagus fahraei (Gyllenhal) [= *C. striatoforatus* = *C. fahraei striatoforatus* = *Metamasius fahraei striatosforatus* = *M. striatoforatus*] (Coleoptera: Curculionidae)	CR, ES, GT, MX, NI, SV	Stem	Yes	No	Anonymous, 1994; Blackwelder, 1956; Lingafelter, 2001; Mann, 1969; Morton, 1997; Romero, 1994; Vaurie, 1967; Wibmer and O'Brien, 1986
Cactophagus sp.[3] (Coleoptera: Curculionidae)	CR, GT, MX, NI, PA, SV	Fruit	Yes	Yes	Blackwelder, 1956; PIN 309, 2001
Cactophagus spinolae (Gyllenhal) [= *C. rubroniger* Fisher] (Coleoptera: Curculionidae)	MX	Stem	Yes	No	Blackwelder, 1956; Mann, 1969
Calligrapha pantherina Stal. (Coleoptera: Chrysomelidae)	NI, MX	Stem	Yes	No	Romero, 1994; Wilcox, 1975
Ceratitis capitata (Wiedemann) (Diptera: Tephritidae)	BZ, CR, GT, HN, NI, PA, SV	Fruit	Yes	Yes	Anonymous, 1999a; Liquido *et al.*, 1991; PIN 309, 2001; White and Elson-Harris, 1992
Chlorochroa sp.[3] [= *Chlochroa* sp.] (Hemiptera: Pentatomidae)	MX	Fruit, Stem	Yes	Yes	Castillo-Martinez *et al.*, 1996
Chauliognathus tricolor (LeConte) (Coleoptera: Cantharidae)	NI	Infl.	Yes	No	Arnett, 1973; Romero, 1994
Cotinis mutabilis (Gory) (Coleoptera: Scarabaeidae)	BZ, CR, GT, HN, MX, NI, US	Stem	No	No	Anonymous, 1994; Arnett, 2000; Barbeau, 1993; Blackwelder, 1956; Morton, 1997
Cyclocephala sp.[3] (Coleoptera: Scarabaeidae)	BZ, CR, GT, HN, MX, NI, PA	Fruit, Infl.	Yes	Yes	Blackwelder, 1956; Castillo-Martinez *et al.*, 1996
Cycloneda sanguinea Linnaeus (Coleoptera: Coccinellidae)	CR, GT, MX, NI, PA, US(AZ, IN)	Infl., Stem	No	No	Anonymous, 1994; Arnett, 1983; Romero, 1994

Organism	Geographic Distribution[1]	Plant Part	Quarantine Pest	Follow Pathway	References
Diabrotica balteata (Leconte) (Coleoptera: Chrysomelidae)	BZ, CR, GT, HN, MX, NI, US	Root, Stem	No	No	Anonymous, 1994; Blackwelder, 1956; CPC, 2001; Romero, 1994
Drosophila spp. (Diptera: Drosophilidae)	CAm, MX, US	Fruit, Infl., Stem	No[2]	Yes	Newby and Etges, 1998; Heed and Mangan, 1986
Dysmicoccus neobrevipes (Beardsley) (Homoptera: Pseudococcidae)	CR, GT, HN, MX, PA, SV	Fruit	Yes	Yes	PIN 309, 2001; Williams and Granara de Willink, 1992
Ecdytolopha sp.[3] (Lepidoptera: Tortricidae)	MX	Fruit	Yes	Yes	PIN 309, 2001
Epilachna borealis (Fabricius) = *E. tredecimnotata* (Latreille) (Coleoptera: Coccinelidae)	BZ, CR, GT, HN, MX, NI, PA, US	Stem	No	No	Anonymous, 1994; Arnett, 2000; Blackwelder, 1956; CPC, 2001; Romero, 1994
Estigmene acrea (Drury) [= *E. ocrea*] (Lepidoptera: Arctiidae)	CR, GT, HN, MX, NI, SV, US	Stem	No	No	Arnett, 2000; Castillo-Martinez *et al.*, 1996; CPC, 2001
Euchistus servus (Say) (Hemiptera: Pentatomidae)	MX	Fruit, Stem	Yes	Yes[2]	Castillo-Martinez *et al.*, 1996
Euphoria limatula (Janson) (Coleoptera: Scarabaeidae)	CR, GT, MX, NI	Fruit, Infl.	Yes	Yes[2]	Anonymous, 1994; Blackwelder, 1956; Morton, 1997; Romero, 1994
Euxesta major (Van der Wulp) (Diptera: Otitidae)	GT, MX, NI, SV	Infl.	No	No	Anonymous, 1994; McGuire and Crandall, 1967; Romero, 1994
Gracillariidae sp.[3] (Lepidoptera: Gracillariidae)	BZ, CR, GT, HN, MX, NI, PA, SV	Fruit, Stem	Yes	Yes	PIN 309, 2001
Leptoglossus sp.[3] (Hemiptera: Coreidae)	MX	Fruit, Infl., Stem	Yes	Yes	Castillo-Martinez *et al.*, 1996
Leptoglossus zonatus (Dallas) [= *Anisoscelis zonatus*] (Hemiptera: Coreidae)	CAm, MX, NI, US	Fruit, Stem	No	Yes	Anonymous, 1994; Barbeau, 1993; Essig, 1926; Johnson and Lyon, 1976; Morton, 1997; Romero,

Organism	Geographic Distribution[1]	Plant Part	Quarantine Pest	Follow Pathway	References
					1994
Melipona sp.[3] (Hymenoptera: Apidae)	MX	Fruit	Yes	Yes	Castillo-Martinez *et al.*, 1996
Narnia femorata Stal. (Hemiptera: Coreidae)	MX, US	Fruit	No	Yes	Essig, 1926
Ogdoecosta biannularis (Boheman) (Coleoptera: Chrysomelidae)	MX	Fruit	Yes	Yes	Blackwelder, 1956; PIN 309, 2001
Olethreutinae sp.[3] (Lepidoptera: Tortricidae)	CR, GT, HN, MX, NI, PA, SV	Fruit	Yes	Yes	PIN 309, 2001
Opuntiaspis philococcus (Cockerell) (Homoptera: Diaspididae)	MX	Fruit, Stem	Yes	Yes[2]	Hamon, 1980; Miller *et al.*, 1985; PIN 309, 2001
Ozamia sp.[3] (Lepidoptera: Pyralidae)	MX	Fruit	Yes	Yes	PIN 309, 2001
Pantomorus femoratus (Sharp) (Coleoptera: Curculionidae)	NI	Infl., Stem	Yes	No	Romero, 1994
Phycitinae sp.[3] (Lepidoptera: Pyralidae)	BZ, CR, GT, HN, MX, NI, PA, SV	Fruit	Yes	Yes	PIN 309, 2001
Planococcus minor (Maskell) (Homoptera: Pseudococcidae)	CR, GT, HN, MX	Fruit	Yes	Yes	PIN 309, 2001; Williams and Granara de Willink, 1992
Planococcus sp.[3] (Homoptera: Pseudococcidae)	BZ, CR, GT, HN, MX, PA, SV	Fruit	Yes	Yes	PIN 309, 2001
Platynota sp.[3] (Lepidoptera: Tortricidae)	MX	Fruit	Yes	Yes	PIN 309, 2001
Proxys punctulatus (Polisot) (Hemiptera: Pentatomidae)	NI, US	Fruit, Infl.	No	Yes	Anonymous, 1994; Blatchley, 1926; Romero, 1994
Pseudococcidae sp.[3] (Homoptera: Pseudococcidae)	NI	Fruit	Yes	Yes	PIN 309, 2001
Puto sp.[3] (Homoptera: Pseudococcidae)	CR, GT, HN, MX, SV	Fruit, Stem	Yes	Yes	PIN 309, 2001
Pyraustinae sp.[3] (Lepidoptera: Pyralidae)	BZ, CR, GT, HN, MX, NI, PA, SV	Fruit	Yes	Yes	PIN 309, 2001
Quadraspidiotus sp.[3] (Homoptera: Diaspididae)	MX	Fruit, Stem	Yes	Yes	Castillo-Martinez *et al.*, 1996
Solenopsis sp.[3] (Hymenoptera: Formicidae)	MX, NI	Fruit, Infl., Stem	Yes	Yes	Anonymous, 1994; Castillo-Martinez *et al.*, 1996; Hill,

Organism	Geographic Distribution[1]	Plant Part	Quarantine Pest	Follow Pathway	References
					1983; Morton, 1997; Romero, 1994
Solenopsis geminata Fabricius (Hymenoptera: Formicidae)	MX, US	Fruit, Infl., Stem	No	Yes	Hill, 1983; Morton, 1997
Stenygra histria (Serville) [= *S. histrio*] (Coleoptera: Cerambycidae)	CR, GT, MX, NI	Stem	Yes	No	Blackwelder, 1956; Romero, 1994
Systena sp.[3] (Coleoptera: Chrysomelidae)	BZ, CR, GT, HN, MX, NI, PA	Fruit	Yes	Yes	Blackwelder, 1956; PIN 309, 2001
Vanduzea sp.[3] (Homoptera: Membracidae)	MX	Fruit, Stem	Yes	Yes	PIN 309, 2001
MOLLUSCA					
Milax sp.[3] (Stylommatophora: Limacidae)	MX	Stem	Yes	No	Castillo-Martinez *et al.*, 1996
BACTERIA					
Erwinia carotovora (L. R. Jones) Holland (Proteobacteria: γ, Enterobacteriaceae)	BZ, CR, GT, HN, MX, NI, PA, SV, US	Stem	No	No	Anonymous, 1994; Castillo-Martinez *et al.*, 1996; CPC, 2001
Xanthomonas campestris (Proteobacteria: γ, Lysobacterales)	NI, US	Stem	No	No	Barbeau, 1993
Yeasts (primarily *Pichia* spp. and *Candida* spp.) and various saprophytic bacteria	CAm, MX, US	Fruit, Infl., Stem	No[2]	Yes	Fogleman and Starmer, 1985; Foster and Fogleman, 1994; Starmer, 1982; Starmer *et al.*, 1990
FUNGI					
Aecidium sp.[3] (Basidiomycota: Uredinales)	MX	Fruit	Yes	Yes	Palm, 2001; PIN 309, 2001
Cladosporium sp.[3] (Ascomycota: Dothideales)	HN, MX, NI	Fruit, Stem	Yes	Yes	Anonymous, 1994; PIN 309, 2001
Dothiorella sp.[3] [= *Dothiorela* sp.] (Mitosporic Fungi)	MX, NI	Stem	Yes	Yes	Anonymous, 1994; Castillo-Martinez *et al.*, 1996

Organism	Geographic Distribution[1]	Plant Part	Quarantine Pest	Follow Pathway	References
Fusarium oxysporum (Schlecht ex Fries) (Mitosporic Fungi)	MX, NI, US (MS, TX)	Stem	No	No	Anonymous, 1994; CPC, 2001; Farr *et al.*, 1989
Glomerella cingulata (Stoneman) Spaulding & Schrenk [anamorph *Colletotrichum gloeosporioides* Penz. & Sacc.] (Ascomycota: Phyllachorales)	BZ, CR, GT, HN, MX, NI, PA, US (FL, HI)	Stem	No	No	Anonymous, 1994; Castillo-Martinez *et al.*, 1996; CPC, 2001; Farr *et al.*, 1989
Helminthosporium sp.[3] (Note: *H. cactivorum* is in US(TX) (Mitosporic Fungi)	NI	Stem	Yes	No	Anonymous, 1994
Phomopsis sp.[3] (Ascomycota: Diaporthales)	MX, US (FL)	Fruit	Yes	Yes	Farr *et al.*, 1989; PIN 309, 2001
Placoasterella sp.[3] (Ascomycota: Dothideales)	MX	Stem	Yes	Yes	PIN 309, 2001
NEMATODA					
Helicotylenchus sp.[3] (Nematoda: Haplolaimidae)	NI	Root	Yes	No	Anonymous, 1994
Meloidogyne sp.[3] (Nematoda: Heteroderidae)	NI, US(TX)	Root	Yes	No	Anonymous, 1994

[1]AZ = Arizona, BZ = Belize, CAm = Central America, CR = Costa Rica, FL = Florida, GT = Guatemala, HN = Honduras, HI = Hawaii, IN = Indiana, MS = Mississippi, MX = Mexico, NI = Nicaragua, PA = Panama, PR = Puerto Rico, SV = El Salvador, TX = Texas, US = United States
[2]*See* textual discussion in Section E.
[3]Quarantine pests identified only to the order, family or generic levels are not further analyzed in this risk assessment with the exception of *Anastrepha* spp. (*See* Section E discussion).
[4]Infl. = Inflorescence

E. Quarantine Pests that are Likely to Follow The Pathway

The quarantine pests of *Hylocereus* spp. that are reasonably be expected to follow the pathway on fruit are further analyzed in this risk assessment. This includes the fruit flies in the genus *Anastrepha*, the fruit fly *Ceratitis capitata*, and two mealybugs, *Dysmicoccus neobrevipes* and *Planococcus minor*. These pests were intercepted on pitaya at some time from various countries (PIN 309, 2001), but the interception record does not indicate a particular species within the genus *Anastrepha*. Rather than arbitrarily selecting an individual species of *Anastrepha* for analysis, this risk assessment assesses the entire genus because many species of *Anastrepha* are present in Mexico and Central America (Hernandez-Ortiz, 1992; Sequeira *et al.*, 2001; White and Elson-Harris, 1992). Individual members of the genus are likely to vary in their ability to use this plant as a host (Sequeira *et al.*, 2001), and a relatively higher degree of uncertainty is associated with these ratings than with the other pests.

There was an interception of *Ceratitis capitata* larva in *Hylocereus* fruit from Argentina, and a species of Tephritidae was intercepted in pitaya fruit from France (PIN 309, 2001). The only tephritid with a host range wide enough to account for such an infestation that occurs in France is *C. capitata* (White and Elson-Harris, 1992). Egg laying in this host occurred in a laboratory (Liquido *et al.*, 1991). This suggests that *C. capitata* can use *Hylocereus* as a host wherever they both occur, even if it is not a preferred host.

The two mealybugs, *D. neobrevipes* and *P. minor* were intercepted during 2001 from species of *Hylocereus* from Vietnam and Singapore, respectively (PIN 309, 2001). Both pests are distributed throughout Mexico and Central America (Williams and Granara de Willink,1992).

Table 4. Quarantine Pests Likely to Follow the Pathway and Selected for Further Analysis
Anastrepha spp. (Diptera: Tephritidae) *Ceratitis capitata* (Wiedemann) (Diptera: Tephritidae) *Dysmicoccus neobrevipes* (Beardsley) (Homoptera: Pseudococcidae) *Planococcus minor* (Maskell) (Homoptera: Pseudococcidae)

Other plant pests listed in Table 3 that were not chosen for further scrutiny may be potentially detrimental to the agricultural systems of the United States, however, there were a variety of reasons for not subjecting them to further analysis. First, the pest's primary association may be with plant parts other than the commodity, such as *Cycloneda sanguinea* (Arnett, 1983; Borror *et al.*, 1989). Secondly, the pests may not be associated with the commodity during transport or processing because of their inherent mobility and/or instinct to avoid light, or human activity, such as *Alkindus atratus* (Henry and Froeschner, 1988; Saunders *et al.*, 1983), *Euchistus servus*, *Euphoria limatula* (Blackwelder, 1956; Morton, 1997), *Leptoglossus zonatus* (Barbeau, 1993; Johnson and Lyon, 1976; Morton, 1997), *Narnia femorata*, and *Ogdoecosta biannularis* (Blackwelder, 1956). Thirdly, sterile insect stages (ant workers) can be transported in a shipment but are unable to establish viable populations upon entry, such as *Atta cephalotes*, *Atta* spp., *Solenopsis geminata*, and *Solenopsis* spp. (Borror *et al.*, 1989). Lastly, pests may be intercepted during inspection by Plant Protection and Quarantine Officers as biological contaminants of the commodity, but these are not be expected to be present with every shipment (PIN, 309).

Scale insects, such as *Acutaspis albopicta* and *Opuntiaspis philococcus*, may follow the pathway as eggs, larvae (immature crawlers), or adults on harvested fruit (Borror *et al.*, 1989; Miller *et al.*, 1985). The larvae are mobile and search for suitable locations to feed, but after establishing feeding sites on the surfaces of stems, fruit, or other plant parts, they become immobile (Borror *et al.*, 1989). Adult females are sessile (Borror *et al.*, 1989) and generally are visible during harvest and culling procedures. Due to the number of biotic and abiotic circumstances that must successfully interact, hard scale insect species that may be associated with pitaya generally have a low probability of establishment from infested shipments of commercial fruit (Miller *et al.*, 1985) so they are not further analyzed.

The associations among host plants, *Drosophila* species, yeasts and bacteria are a well studied system of saprophytic interactions (Etges, 1993; Foster and Fogelman, 1994; Heed and Mangan, 1986; Newby and Etges, 1998; Ruiz and Heed, 1988; Starmer *et al.*, 1990). The four species of *Drosophila* endemic to the United States (*D. mojavensis* Patterson, *D. pachea* Patterson & Wheeler, *D. nigrospiracula* Patterson & Wheeler, and *D. mettleri* Heed) are phylogenetically related to the species present in Mexico, Guatemala and the West Indies (Heed and Mangan, 1986). Five distinct complexes of cactophilic yeast were identified in the genus *Pichia* (Starmer *et al.*, 1990), species of *Candida* are part of the community structure (Fogelman and Starmer, 1985; Phaff *et al.*, 1994; Starmer, 1982), and 30 conspecific groups were identified from 337 different bacterial isolates (Foster and Fogleman, 1994). The yeasts and bacteria provide food for insect growth and development as they rot cactus tissue, and the insects provide dispersal for these organisms (Heed and Mangan, 1986; Latham, 1998; Starmer *et al.*, 1990). For the purposes of this risk assessment, the specifics of the interactions in each biogeographic region are unessential because generally, saprobes are not pests of quarantine concern. The culling of rotting fruit should prevent the transport and potential entry of any of these or other unidentified organisms that are part of this saprophytic system.

The biological hazard of organisms identified only to the order, family or generic levels also is not assessed (with the previously discussed exception of *Anastrepha* spp.) but if pests identified only to higher taxa are intercepted in the future, then reevaluations of their risk may occur. In this risk assessment, this applies to the following 21 arthropod taxa: *Apiomerus*, *Atta*, *Cactophagus*, *Chlorochroa*, *Cyclocephala*, *Ecdytolopha*, Gracillariidae, *Leptoglossus*, *Melipona*, Olethreutinae, *Ozamia*, Phycitinae, *Planococcus*, *Platynota*, Pseudococcidae, *Puto*, Pyraustinae, *Quadraspidiotus*, *Solenopsis*, *Systena* and *Vanduzea*. It applies to the mollusk *Milax*, and the nematodes *Helicotylenchus* and *Meloidogyne*. It also applies to the following six fungal genera: *Aecidium*, *Cladosporium*, *Dothiorella*, *Helminthosporium*, *Phomopsis* and *Placoasterella*.

The interception of *Aecidium* spp. is of concern because the literature reports *Aecidium cerei* Hennings on species of *Cereus* but not species of *Hylocereus* (Palm, 2001). The risks associated with rust fungi on fruit of *Hylocereus* spp. will be evaluated if rust fungi are intercepted on species of *Hylocereus* in the future.

Generally, the biological hazard of organisms not identified to the species level is not assessed because often there are many species within a genus, and it is not reasonable to assume that the biology of all organisms within a genus is identical. Lack of species identification may indicate the limits of the current taxonomic knowledge or the life stage or the quality of the specimen submitted for identification. By necessity, pest risk assessments focus on the organisms for which biological information is available. The lack of identification at the specific level does not rule out either the possibility that a high risk quarantine pest was intercepted or that the intercepted pest was not a quarantine pest. Conversely, development of detailed assessments for known pests that inhabit a variety of ecological niches, such as the surfaces or interiors of fruit, stems or roots, allow effective mitigation measures to eliminate the known organisms as well as similar but incompletely identified organisms that inhabit the same niche.

F. Consequences of Introduction

The undesirable consequences that may occur from the introduction of quarantine pests are assessed within this section. For each quarantine pest, the potential consequences of introduction are rated in five areas called "Risk Elements". They are: Climate-Host Interaction, Host Range, Dispersal Potential, Economic Impact and Environmental Impact. These Risk Elements reflect the biology, host range and climatic/geographic distribution of each pest and are supported by biological information on each of the analyzed pests. For each risk element, pests are assigned a rating of Low (1 point), Medium (2 points), or High (3 points). A cumulative risk rating is then calculated by summing the values. The ratings are summarized in Table 6. The ratings were determined using the criteria in the risk assessment Guidelines, Version 5.02 (USDA, 2000).

Anastrepha spp.

These fruit flies attack fleshy-fruited species in over twenty genera in a variety of families (CPC, 2001) that occupy the southern tier of the United States as native, cultivated and introduced plants (Kartesz, 1998; NRCS, 2001; Small, 1913). The life cycle of *Anastrepha* species frequently is less than 75 days from egg-laying until adult emergence so there can be many generations per year with adequate temperature and moisture, and females produce eggs singly or in clutches (Sequeira *et al.*, 2001). The larvae could be transported for long distances in international trade, and adults are reported to fly over 100 km in a series of flights (EPPO, 1992; Fletcher, 1989; PNKTO, 1983).

These fruit flies lower yield because medium to high infestations cause premature fruit drop in many host species. The pests lower the value of the commodity by increasing the costs of chemical controls for adults, and larvae may make the fruit completely unmarketable (PNKTO, 1983, Sequeira, 2001), causing the loss of international and interstate markets. These pests are polyphagus, and the possibility of extension of the host range when introduced into a new geographical area cannot be discounted. These pests may stimulate the need for chemical or biological control programs (Fletcher, 1989; Stone, 1942; White & Elson-Harris, 1992). They may harbor a wide variety of common soil- and water-inhabiting Enterobacteriaceae in their gut (Kuzina *et al.*, 2001).

Infestation of rare and other native plant species by *Anastrepha* spp. could cause negative impacts to plant community diversity and wildlife at a regional level due to the potential loss of fruit and seed set (ARS, 2001; Harlow *et al.*, 1996; Martin *et al.*, 1951). Specifically, native pomaceous and drupaceous species of Rosaceae (e.g., *Crataegus, Mespilus, Prunus, Sorbus*) and native *Diospyros* may be at risk of attack by the mexfly (*Anastrepha ludens*) (ARS, 2001; Harlow *et al.*, 1996; Martin *et al.*, 1951). Commercial host groves and a port of entry are within the vicinity of a State-listed species habitat providing a potential reservoir for the mexfly. Stands of *Prunus myrtifolia* near the Miami port are likely to be adversely affected if the mexfly became established in that area (USFWS, 2001b; Wunderlin and Hansen, 2001). In southern Florida, the relative proximity of ports of entry, commercial hosts, and rare species increases the consequences of *Anastrepha* introduction and establishment.

The *A. fraterculus* complex has two or more predominant types (Baker *et al.*, 1944) that are morphologically and genetically distinct (Steck *et al*, 1990; Steck and Sheppard, 1993). The Mexican form has a narrower host range than the South American form (Baker, 1944). The natural range of *Anastrepha fraterculus* (complex) includes much of South America northward through Mexico. In the U.S., it was trapped in southern Texas (Hardiness Zone 9) but this fruit fly could establish in Zones 10 and 11 as well. In Mexico, it attacks plants in at least seven plant families: Rubiaceae, Rosaceae, Myrtaceae, Anacardiaceae, Sapotaceae, Combretaceae and Euphorbiaceae (Hernandez-Ortiz, 1992). The demonstrated capacity of this fruit fly to infest a wide variety of hosts indicates that it has the potential to expand its known host range when introduced to new geographical areas (Fletcher, 1989; Stone, 1942; White & Elson-Harris, 1992). Its life cycle, from egg-laying until adult emergence, ranges from 33 to 57 days, and there may be six to seven generations per year (Fletcher,1989). In Peru, up to 50 eggs may be laid in single fruit, depending on maturity and variety of host fruit.

While current control measures may be sufficient to reduce or limit the spread of *A. fraterculus* within a cropping area, this fruit fly's ability to impact non-cultivated species means that a reservoir population is likely to establish outside of an agroecosystem. If this happened, ongoing mitigation measures would be required to economically produce a crop.

The natural range for *A. ludens* is Mexico, Central America, and the Rio Grande Valley of Texas (some populations migrate each fall and winter from Mexico into the Rio Grande Valley). It occurs in one climate zone in Texas and probably could establish in two more zones. In Mexico, this pest attacks hosts in seven plant families (Hernandez-Ortiz, 1992). The life cycle, from egg-laying until adult emergence, ranges from 33 to 63 days. The number of generations per year can range from 1 to over 12. A single female may produce several hundred eggs (PNKTO, 1983; EPPO, 1992).

In contrast, *Anastrepha serpentina* occurs abundantly in Mexico and most countries of Central and South America (south to Brazil). It reportedly occurred in southern Texas, "but seldom has been found since about 1959" (Foote, *et al.*, 1993). It may establish in two or more climactic zones. In Mexico, this pest occurs on hosts in at least six plant families (Hernandez-Ortiz, 1992). The range of this pest is reported as about 40 plant species in 13 plant families (Norrbom and Kim, 1988).

Ceratitis capitata

The fruit fly *C. capitata* is widely distributed throughout most of Africa, the Mediterranean, Hawaii, much of Central and South America, and Australia. It was accidentally introduced and subsequently eradicated from Florida, California, and Texas several times. It probably could establish in 3 climatic zones (zones 9, 10, and 11) although it generally does not survive sub-zero winter temperatures. It attacks a very wide range of unrelated fruit crops including many deciduous and subtropical fruit trees (Fletcher, 1989; Hendrichs *et al.*, 1983; Metcalf *et al.*, 1962; White and Elson-Harris, 1992). The life cycle of *C. capitata* takes about a month from egg to adult; there may be eight to ten generations per year. Larval infested fruit can be transported great distances (*e.g.* PIN 309, 2001). There is evidence that *C. capitata* can fly at least 20 km (Fletcher, 1989).

This pest lowers the value of the commodity by increasing the costs of chemical controls, and larvae may make the fruit completely unmarketable, causing the loss of international and interstate markets (Andrew *et al.*, 1977). Infestation of hosts by *C. capitata* in this country may cause ecological disruption or reduced biodiversity at a regional level because of the large number of hosts and their roles in native ecosystems and as cultivated crops. Native pomaceous and drupaceous species of Rosaceae (e.g., *Crataegus, Mespilus, Prunus, Sorbus*) and native *Diospyros* and *Juglans* from Florida to California are likely to be at risk from medfly infestations. In Florida, commercial groves of hosts that are near a port of entry are within the vicinity of State-listed species habitats and are likely to act as a continuing source of medflies (USFWS, 2001b). Infestation of rare and other native plant hosts could cause negative impacts to plant community diversity and wildlife due to the potential loss of fruit and seed set (Martin *et al.*, 1951; ARS, 2001; Harlow *et al.*, 1996).

Dysmicoccus neobrevipes

The gray pineapple mealybug, *D. neobrevipes*, is distributed in Thailand, the Phillippean Islands, the South Pacific Islands, Hawaii, northern South America and the Neotropical Islands (Ben-Dov, 1994; Rohrbach and Apt, 1986). Based on climates inhabited by this pest, the corresponding US Plant Hardiness Zones that appear suitable for population establishment by *D. neobrevipes* range from zones 8-10 (USDA, 1990). Hosts for *D. neobrevipes* include a wide variety of species from at least thirty-three plant families (Ben-Dov, 1994; CPC, 2001; PIN 309, 2001; Williams and Granara de Willink, 1992).

In contrast to fruit flies, this mealybug appears to be slowly dispersed by its first instar stage which actively crawls short distances on the same plant or to neighboring plants within one day (CPC, 2001). The average number of first instar larvae produced per female was over 345 and several generations occurred each year in life history studies conducted by Ito in the 1930's (Beardsley, 1959). Within-field dispersal of *D. neobrevipes* when assisted by big-headed ants in pineapple fields was measured at 27.5 m in 3 months (Beardsley *et al.*, 1982). Long-distance dispersal of all life stages occurs on consignments of plant material and fruit as demonstrated by over 1,300 interceptions from over 40 countries (PIN 309, 2000). *Dysmicoccus* species also are dispersed by wind and animals (CPC, 2001).

Although less is known about this mealybug than the closely related *D. brevipes*, *D. neobrevipes* is a serious economic pest of tropical or subtropical crops. Colonization and feeding on pineapple occur on the basal parts of leaves and fruit and "honeydew" excretions are a food source for black sooty molds which reduces the market value of fruit (CPC, 2001). This insect is associated with "Pineapple mealybug wilt disease" as a vector of the closterovirus that causes yield reductions (CPC, 2001). Biological and chemical control measures frequently are needed to control mealybugs, attending ants and sooty molds (CPC, 2001; Beardsley *et al.*, 1982) because this complex of pests lowers crop yield and reduces the crop's market value (Rohrbach and Apt, 1986; Rohrbach *et al.*, 1988).

Planococcus minor

The mealybug *P. minor* is reported in the South Pacific islands, the Austro-oriental region, the Malagasian region, and the northern Neotropical region (Cox, 1989). It may infest plants simultaneously with *P. citri* (Williams and Granara de Willink, 1992). Based on the climates that *P. minor* inhabits, the corresponding localities that appear suitable for population establishment are US Plant Hardiness Zones 8 to 10. The host range for *Planococcus minor* includes at least 59 mostly tropical and subtropical species from thirty-six plant families (Cox, 1989; Kartesz, 1998; NRCS, 2002). This pest completed 10 generations per year and averaged 260 eggs per generation on mandarin (Sahoo *et al.*, 1999). Local distribution within fields was limited, but over 1900 interceptions of this pest on various hosts from over 30 countries were reported since 1985 (PIN 309, 2000).

Chemicals and natural enemies control mealybugs either independently or in combination. The success of biological control programs, however, depends on proper identification of the mealybug (Cox, 1989). There are no control measures specific to *P. minor* in the literature, and information on its natural enemies is limited. The closely related mealybug *P. citri* was reported as a virus vector in cocoa (Roivainen, 1980), but whether *P. minor* can serve as a vector is unknown.

Both of the mealybugs could cause ecological disruption or reduced biodiversity at the regional level because of their large number of hosts and the roles of those hosts in native ecosystems. If *D. neobrevipes* established populations throughout its potential range in the continental United States, then native plants may be impacted based on this pest's effects on Hawaiian plants listed as Threatened or Endangered species (USFWS, 2001a) which suggest that additional infestations by another mealybug pose additional risk to at-risk plant populations (Rohrbach and Apt, 1986; Rohrbach *et al.*, 1988).

Table 5. Potential hosts listed as Threatened or Endangered Species (USFWS, 2001a) that correspond to host genera of *Ceratitis capitata* (CECA), *Dysmicoccus neobrevipes* (DYNE) and *Planococcus minor* (PLMI).

Host Genera[1] (Family)	Threatened or Endangered species[2]	Status	Distribution of T&E species	Potential Pests

Agave (Agavaceae)	*Agave arizonica* Gentry & Weber	E	AZ	DYNE
Justica (Amaranthaceae)	*Justicia cooleyi* Monach & Leonard	E	FL	PLMI
Amaranthus (Amaranthaceae)	*Amaranthus pumilus* Raf.	T	MD, NC, NY, SC	PLMI
Helianthus (Asteraceae)	*Helianthus eggertii* Small	T	AL, KY, TN	PLMI
Opuntia (Cactaceae)	*Opuntia basilaris* var. *treleasi* Coult. ex Tourney	E	AZ, CA	CECA, DYNE
Cucurbita (Cucurbitaceae)	*Cucurbita okeechobeensis* subsp. *okeechobeensis* Duncan & Pullen	E	FL	DYNE, PLMI
Euphorbia (Euphorbiaceae)	*Euphorbia telephioides* Chapm.	T	FL	PLMI
Manihot (Euphorbiaceae)	*Manihot walkerae* Croizat	E	TX	PLMI
Prunus (Rosaceae)	*Prunus geniculata* Harper	E	FL	CECA[3]
Verbena (Verbenaceae)	*Verbena californica* Moldenke	T	CA	PLMI

[1]ARS, 2001; ARS-SEL, 2001; CPC, 2001; Solomon, 2002.
[2]ARS, 2001; Hickman, 1993; USFWS, 2001a
[3]*Anastrepha ludens* also could become a potential pest of *Prunus geniculata* if established, but the potential host ranges for all *Anastrepha* species were not exhaustively examined for the purposes of generating this table.

Table 6. Risk Element Ratings: Consequences of Introduction Values

Pest	Climate/ Host	Host Range	Dispersal Potential	Economic	Environ-mental	Consequences of Introduction Value
Anastrepha spp.	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)
Ceratitis capitata	High (3)	High (3)	High (3)	High (3)	Medium (2)	Medium (14)
Dysmicoccus neobrevipes	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (14)
Planococcus minor	High (3)	High (3)	High (3)	High (3)	High (3)	High (15)

G. Likelihood of Introduction

The Likelihood of Introduction for each pest is based on two separate components. First, the amount of the commodity likely to be imported (Risk Element #6) is supplied by the proposed country of export and is converted into standard units of 40-foot long shipping containers. Secondly, the Pest Opportunity (Risk Element #7) is estimated using five biological features (USDA, 2000). These ratings and the value for the Likelihood of Introduction are summarized in Table 7.

In 1999, the exportable production from Mexico was approximately 760 tons of pitaya, based on the report of 10.37 tons per hectare on 73 hectares (Grosser, 2002). Assuming there are 20 metric tons per 40-foot long container, this converts to a volume of exports of 38 containers. This corresponds to a rating of Medium (USDA, 2000) for this risk element because it is likely to represent the maximum volume that will enter from any of these countries on a yearly basis. This risk assessment assumes that any increases in production in subsequent years are offset by all exports not being destined for the United States, and that each country considered in this risk assessment will not export to the United States a substantially greater volume in any year.

The ratings for the Pest Opportunity are based on the biological features exhibited by the pest's interaction with the commodity and represent a series of independent events that must all take place before a pest outbreak can occur. The five components of the Pest Opportunity consider: (1) the availability of postharvest treatments, (2) whether the pest can survive through the interval of normal shipping procedures, (3) whether the pest can be detected during inspection, (4) the interactions among factors that influence the rate of establishment, and (5) the availability of suitable hosts for the pest to survive on. These components are a series of independent events that must all occur for a pest outbreak. The cumulative risk value is an indicator of the likelihood that a particular pest would be introduced.

All of the pests were rated High (3) for their ability to Survive Postharvest Treatment because post harvest treatments for this crop consist of brushing off the thorns (Meija *et al.*, 2002). This process is unlikely to detect any internally feeding fruit fly larvae, and young mealybug life stages are likely to avoid detection if they are present in the crevices associated with removed thorns.

All of the pests were rated High (3) for Survive Shipment because these quarantine pests are easily able to survive and potentially reproduce during relatively short shipment durations. The fruit flies are internal and protected within the fruit (Weems, 1981; Narayanan and Batra, 1960). Most life-stages of the mealybugs are firmly attached to the fruit and protected by a self-secreted waxy covering (Borror *et al.*, 1989; Cox, 1989).

The mealybugs were rated Medium (2) for Not Detected at the Port of Entry because these quarantine pests generally are large enough to be seen by trained inspectors, there are color differences between the pests and the fruit, and first instar larvae are likely to be seen as they move. Yet these are relatively small pests that are expected to be few in number. In contrast, the internal fruit fly larvae can only be detected by destructive sampling methods (Weems, 1981) which merits a High rating (3).

Both of the fruit fly pests were rated Medium (2) for Moved to a Suitable Habitat because the majority of the country is too cold to be considered locations suitable for fruit fly survival (Sequeira *et al.*, 2001). The high level of transport in trade for *P. minor* merits a High rating (3) because the motile stage of this pest is more likely to find a suitable host (Cox, 1989). The Medium rating (2) for *D. neobrevipes* reflects its need for tropical/neo-tropical climates and lack of capability for directed movement. All of the pests were rated High (3) for Contact with Host Material because they are reasonably expected to find a suitable host given their wide host ranges.

Table 7. Summary of Risk Element #6: Quantity imported annually, Risk Element #7: Pest Opportunity, and the Value for the Likelihood of Introduction							
Pest	Risk Element #6: Quantity imported annually	Risk Element #7: Pest Opportunity					Likelihood of Introduction Value
		Survives post-harvest treatment	Survives shipment	Not detected at the port of entry	Moved to a suitable habitat	Finds a suitable host	
Anastrepha spp.	Medium (2)	High (3)	High (3)	High (3)	High (3)	High (3)	High (17)
Ceratitis capitata	Medium (2)	High (3)	High (3)	High (3)	High (2)	High (3)	High (17)
Dysmicoccus neobrevipes	Medium (2)	High (3)	High (3)	Low (1)	Medium (2)	High (3)	Medium (14)
Planococcus minor	Medium (2)	High (3)	High (3)	Low (1)	High (3)	High (3)	High (15)

H. Conclusion

The sum of the values for the Consequences of Introduction and the Likelihood of Introduction produce the Pest Risk Potential value. This cumulative total expresses the risk on the following scale: Low = 11-18 points, Medium = 19-26 points, and High = 27-33 points. The results for the four pests are summarized in Table 8.

Table 8. Summary of the values for the Consequences of Introduction and the Likelihood of Introduction and the Pest Risk Potential			
Pest	Consequences of Introduction Value	Likelihood of Introduction Value	Pest Risk Potential
Anastrepha spp.	High (15)	High (17)	High (32)
Ceratitis capitata	Medium (14)	High (17)	High (31)
Dysmicoccus neobrevipes	Medium (14)	Medium (14)	High (28)
Planococcus minor	High (15)	High (15)	High (30)

Pests with an overall Pest Risk Potential value of Low typically do not require mitigation measures, while a value within the Medium range indicates that specific phytosanitary measures may be necessary. All the organisms within this risk assessment had analysis values within the

High range for their Pest Risk Potential. For all of the pests listed in Table 4, port-of-entry inspection is insufficient to provide phytosanitary security, and the development of specific phytosanitary measures is recommended. The culling of rotting fruit is needed to prevent the transport and potential entry of saprophytic organisms that are not recognized as quarantine pests. The choice of appropriate measures to mitigate risks is part of Risk Management within APHIS, and is not addressed within this risk assessment document.

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